ETL216

Design, Make, Appraise

Assessment Item 1

Sem 2, 2011

Contents

INTRODUCTION

The growing awareness of the extensive diversity and influences of technology - historically, presently, and in the future - seems to have made it difficult to confine and define. Technology education was introduced into the Australian national curriculum in the 1990's, and variations of a "Design, Make, Appraise" process (DMA) was developed as a model to assist inexperienced teachers. The NT Curriculum Framework describes a similarly interconnected process of "Critiquing, Designing, Producing" in the Technology and Design Learning Area (2009). However, Mawson (2001) argues the model is not a suitable model to reflect real technological practice, and suggests that its use can effectively serve to limit intuitive and creative technological activity, as specific skills in drawing, modelling, tool use, and properties of materials are often lacking. It has been proposed by Fleer & Jane (2011) that teachers may better control the technology learning experience for students through their choice of design briefs, yet concede that more research is required.

This report documents the author's personal experience of the cyclical "Design, Make, Appraise" process during the construction of an electromagnet to meet the requirements of an open design brief. Photographs of this process are included in an accompanying Powerpoint presentation.

THE DESIGN BRIEF

The design brief has been established by the assessment task:

> *"**Design, make and appraise** an artefact which could be used as a teaching aid. It must include at least two recycled items and have a moving part."*

THE PROCESS OF DESIGN

BRAINSTORMING

To support my personal learning goals while addressing the design brief, I looked to the NT Curriculum Framework Science Learning Area: Energy and Change, and considered outcomes in bands 2-3 including pulleys, magnets, and circuits. Some of these ideas were posted amongst fellow students on the Learnline Discussion Board from approximately 11/08/2011.

I was inspired by Dr Brian Lewthwaite's CDU presentation (Learnline 2011, p27) to learn to construct a basic electromagnet from entirely recycled parts, incorporating concepts of magnets and circuits. During investigations into how to do this, I found plans for an electromagnetic crane model (Baker & Haslam, 1992) which also incorporated a moving pulley system.

ORIGINAL PROPOSAL

I decided to construct my own version of an electromagnetic crane, using readily-available materials that I had already begun to recycle or reclaim. This was specified in posts on the Learnline Discussion Board on 03/09/2011. The electromagnetic circuit would be mostly unseen, mounted inside a cardboard frame of a crane.

PLANNING

As a large number of images and suggestions are readily available on the internet, and the principle generally appeared fairly consistent, I felt I would begin by trying to replicate a simple electromagnet to explore how they worked, certain that I could not imagine how to adapt a system until I had experienced one.

Figure 1. An electromagnet at its most basic – insulated wire wrapped around an iron nail will produce a moderate magnetic field when wire ends are in contact with positive and negative ends of a household battery. The ends of the nail carry the strongest magnetic force and can attract small iron or steel items.

MATERIALS INVESTIGATION

I was confident with the properties of corrugated cardboard for the crane frame, planning to glue extra layers if extra rigidity was required.

There are only four essential components to a simple electromagnet, however the instructions and examples often used one or two specific components that I did not have, and it was not immediately obvious to me what I could safely use as substitutes. Of most concern to me was which type of wires and batteries would be safe to use together. I had to seek advice about sources of appropriate wire from a salesperson at Jaycar Electronics.

Ultimately I was able to clarify and summarise a range of acceptable components:

- a power source (ie: batteries)
- conducting wires (eg: from obsolete household power cords, cables)
- a ferrous rod (eg: iron nails, screws)
- ferrous items to be picked up by the magnet (eg: paperclips, staples, pins...)

SOME PRE-EXISTING KITS AVAILABLE

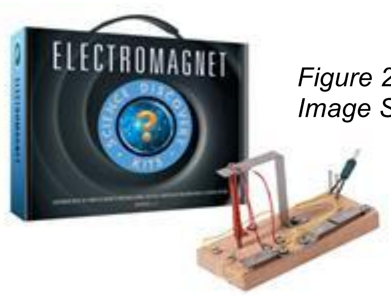

Figure 2. Science Discovery Kit - Electromagnet
Image Source: Educational Magnets

Figure 3. Ein-o's Box Kit - Electromagnet
Image Source: EIN-O's Guide

Figure 4. Simply Science Electromagnet Kit
Image Source: San Jose Scientific

Figure 5. BrainBox Electronics Kit
(no electromagnetic experience included)
Image Source: The Science Fair

PRE-PRODUCTION SKILLS REQUIRED

Despite some theoretical knowledge, I had no previous practical electronics or circuitry experience, and I was deeply concerned about damaging components by sparks, or getting burnt or shocked.

I first experimented with a Brainbox Electronics kit (Fig.5 above), which provides safe snap-on parts and clear instructions to start basic circuits, though no assistance with electromagnets. I then found an EIN-O's Electromagnet Box Kit (Fig.4), which effectively allowed me to experience electromagnetism, but the kit was limited due to some fixed pieces, and some extension activity pieces missing. As my knowledge increased, so did my confidence, and I was ready to start taking "risks".

REASSESS PLANS DUE TO TIME MANAGEMENT

The investigation and skills-building phases took longer than I imagined, so I made the decision not to incorporate the crane frame anymore, as it was only aesthetic and would not affect the functioning of the artefact. Instead I envisaged a hand-held device, mounted somewhat like a metal detector, so its effects were obvious.

THE PROCESS OF CONSTRUCTION

CONSTRUCTING CIRCUITS

Once my knowledge and confidence with circuits had increased, I began building my own improvised electromagnets. The most basic types of circuits were often frustrating, and I identified the following as frequent problems to resolve:

- wires kept slipping from battery terminals
- I regularly burnt my fingers holding wires to the terminals
- when current worked, the drain on battery power was significant
- circuits would suddenly stop working
- accommodation three of the most popular sized batteries, for user convenience

PROBLEM-SOLVING CIRCUITS

To address the problems apparent during construction, I mounted components into corrugated card to prevent slipping, and this was stable enough to act as a "prototype" while I attended to the other problems. I improved terminal connections and developed a range of switches, but I was not completely happy with the solutions when I gathered materials to start mounting the artefact onto wood.

MID-CONSTRUCTION TESTING

The opportunity arose to test my models on my target audience, and they confirmed that the simplest model was difficult and clumsy, and my “prototype” was easier to handle but sometimes required two hands to support, even though it was not heavy.

MID-CONSTRUCTION REDESIGN

Watching others struggle with it, I realised how useful it would be to operate the artefact single-handedly, and decided a long narrow handle would be more ergonomic. I envisaged a standard wooden ruler would be appropriate.

CONSTRUCTING WITH WOOD

I had no woodwork skills and sought advice and instruction for use of suitable tools. I found an offcut of reclaimed pine which was stronger and more ergonomic than a ruler, and would not require significantly different techniques. The thicker wood allowed screws, so I was able to return to a previously overlooked suitable switch. The rest of the construction continued without incident, and after mounting the nail I was able to finish attaching the wire coil. I added a cork to the nail-tip for safety, and secured a durable box to transport it in.

THE PROCESS OF APPRAISAL

EVALUATION OF ARTEFACT BY TARGET GROUP

Evaluators included children from various backgrounds, aged between 3 and 12, and adults from recent refugee background. The completed artefact captured their attention immediately. It was easy for all ages to use and all components stayed intact during extended use and handling. It was described as “magic” while hypotheses about its behaviour commenced and led to further questioning. An assortment of small recycled objects provided an opportunity for an extended investigation into magnets, and in subsequent play it was preferred over regular magnets.

SELF-EVALUATION OF ARTEFACT

The final artefact is a far simpler version of the original design, the crane. In hindsight, I feel justified in keeping the artefact simple with recognisable parts. I can see that outlining a circuit diagram in ink onto the block could increase its teaching function, and it is possible to add more accessories later to increase the range of concepts it can demonstrate.

MEETING THE DESIGN BRIEF

The artefact is composed entirely of recycled and reclaimed components, and has a moving switch which activates the power. I believe it is successful as a teaching aid to demonstrate electromagnetic concepts, but also to stimulate interest and further learning from early primary through to middle school, in Science Energy, Natural and Processed Materials, and Science as Enquiry strands. Extension activities lend themselves to Maths Number and Maths Measurement strands. A technology exercise in deconstructing and reconstructing the artefact using alternative parts would lend itself to the Technology and Design Learning Area, while critical thinking skills required to accomplish the task, and possible teamwork skills, would come under EsseNTial Learnings.

REFLECTION ON PROCESS

I was able to construct a product which not only meets the design brief, but also matches my own values. I am excited about the potential for additions to improve its versatility as a teaching aid now that my confidence with the materials and principles has increased. I really appreciated the opportunity and excuse for hands-on tinkering, though it was incredibly time-consuming to be teaching myself electronics skills and I would have appreciated some formal instruction or demonstration, followed by a guided "play" time. However it was through overcoming perceived difficulties that I have built confidence in my knowledge, learning, and problem-solving abilities.

My experience of the DMA process is that the cyclical process is often repeated in smaller circles and is not always easy to pinpoint, usually as the result of needing to solve a new problem during construction or as a result of testing.

Additionally, I felt I was somehow "failing" or cheating when I did not strictly adhere to the process, or was simply unsure about how to progress and decided to follow my instincts. I believe sometimes a design is a result of opportunity and luck, rather than planning.

CONCLUSION

It could be useful to allow students to undergo a similar process, with an open design brief, as part of their learning about acquiring knowledge. However, I would support a combination of activities, including some where skills and materials knowledge are gradually built upon, and clear boundaries are defined. The idea of "discrete technology learning contexts" are supported by Fleer & Jane (2011, p195) in reference to the system in the UK.

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